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TRANSLATOR CERTIFICATION

I, John Marchioro, a translator fluent in the Japanese language, on behalf of Morningside Evaluations and Consulting, do solemnly and sincerely declare that the following is, to the best of my knowledge and belief, a true and correct translation of the document(s) listed below in a form that best reflects the intention and meaning of the original text.

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John Marchioro JDB
Signature of Translator

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450 SEVENTH AVENUE-SUITE 601-NEW YORK ,NY 10123
PHONE:(212) 904-1015- FAX: (212)904-1025

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(71) Applicant: 00207551
Dainippon Screen Manufacturing Co., Ltd.
4-1-1 Tenjinkita-cho
Teranouchi-agaru
Horikawa-dori
Kamigyo-ku
Kyoto-shi
Kyoto-fu
Japan

(72) Inventor: Yusuke Muraoka
Yasu Business Office, Dainippon Screen Manufacturing Co., Ltd.
2426-1 Aza Kuchinokawahara
Oaza Mikami
Yasu-cho
Yasu-gun
Shiga-ken
Japan

(72) Inventor: Seiichiro Sato
Yasu Business Office, Dainippon Screen Manufacturing Co., Ltd.
2426-1 Aza Kuchinokawahara
Oaza Mikami

Exhibit B

Yasu-cho
Yasu-gun
Shiga-ken
Japan
(74) Agent: Shigeaki Yoshida, Patent Attorney (and 2 others)

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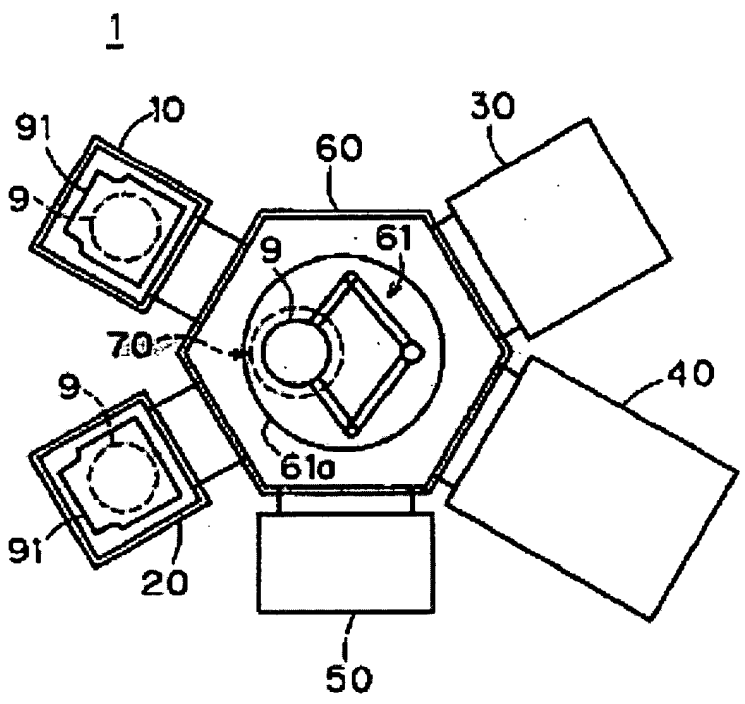
(54) [Title of the Invention] A substrate processing apparatus

(57) [Abstract]

[Problem] To provide a substrate processing apparatus that can improve throughput and can at the same time hold in check the occurrence of defective substrates.

[Means of Solution] A film-thickness measuring part 70 is provided on the upper part of a transfer part 60, in a substrate processing apparatus 1 wherein each processing part has been connected radially to the area around the transfer part 60, this being an apparatus that applies etching with an etching part 30 to the film of a substrate 9. Then, the film thickness of the substrate 9 prior to etching and the film thickness of the substrate 9 after etching are measured by the measuring part 70 in the process of the transfer of the substrate 9 on the inside of the transfer part 60. Owing to this, it is possible to calculate quickly the amount of etching for each etching. As a result, it is possible to improve throughput and can at the same time keep to an absolute minimum the occurrence of defective substrates.

[figure at right]



[Scope of the Patent Claims]

[Claim 1] A substrate processing apparatus, being a substrate processing apparatus that performs the prescribed processing for substrates, characterized in that it is equipped with (a) a transfer part that has a substrate transfer means that carries out the transfer of the substrate, (b) multiple processing parts that include a film thickness alteration processing part that alters the thickness of the that is formed on the surface of the substrate with a processing liquid, and that are disposed in the area around the above-mentioned transfer part, and (c) a film thickness measurement means that measures the thickness of the film before and after the processing by the above-mentioned film thickness alteration processing parts; and in that the above-mentioned substrate transfer means carries out the transfer of the substrate to each of the above-mentioned multiple processing parts.

[Claim 2] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1, wherein the above-mentioned film thickness alteration processing parts carry out etching that alters the thickness of the oxidized film that is formed on the surface of the substrate.

[Claim 3] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1 or Claim 2, that is further equipped with a means that calculates the amount of change in the thickness of the substrate before and after the processing by the above-mentioned film thickness alteration processing parts based on the measurement results from the above-mentioned film thickness measurement means.

[Claim 4] A substrate processing apparatus, being the substrate processing apparatus described in Claim 3, that is further equipped with a modification means that modifies the processing conditions of the substrate in the above-mentioned film thickness alteration processing part based on the amount of change in the thickness of the film that is calculated.

[Claim 5] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1 to Claim 4, that is further equipped with a checking means that checks the kind of film based on the measurement results for the thickness of the film prior to the processing by the above-mentioned film thickness varying processing parts by the above-mentioned film thickness measurement means.

[Claim 6] A substrate processing apparatus, being the substrate processing apparatus described in Claim 5, wherein the processing conditions of the substrate in the above-mentioned film thickness alteration processing parts are modified based on the results of the checking by the above-mentioned checking means.

[Claim 7] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1 to Claim 6, wherein the above-mentioned film thickness measurement means are composed as a single film thickness measurement part that is disposed on the above-mentioned transfer part, and measures the thickness of the film both before and after processing by the above-mentioned film thickness alteration processing means.

[Claim 8] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1 to Claim 6, that is further equipped with (a) a carry-in part that is disposed in the area around the above-mentioned transfer part, and stores the substrate prior to processing by the above-mentioned film thickness alteration processing part, and (b) and a carry-out part that is disposed in the area around the above-mentioned transfer

part, and stores the substrate after processing by the above-mentioned film thickness alteration processing part; and the above-mentioned film thickness measurement means is equipped with (a) a first film thickness measurement part that measures the thickness of the film prior to processing by the above-mentioned film thickness alteration processing means, and (b) a second film thickness measurement part that measures the thickness of the film after processing by the above-mentioned film thickness alteration processing means.

[Claim 9] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1 to Claim 8, characterized in that the above-mentioned film thickness measurement means has (a) a measurement tip for measuring the thickness of the film of the substrate, (b) a position information storage means that stores the position information about where the above-mentioned measurement tip should be positioned relative the substrate during measurement, and (c) and a movement means that moves the above-mentioned measurement tip based on the above-mentioned position information.

[Claim 10] A substrate processing apparatus, being the substrate processing apparatus described in Claim 1 to Claim 8, characterized in that the above-mentioned film thickness measurement means has (a) an area sensor that obtains the image of the prescribed range of the substrate, (b) an area determination means that determines the area to be measured on the substrate from the above-mentioned image, and (c) a film thickness computation means that calculates the thickness of the film in the above-mentioned area to be measured.

[Detailed Description of the Invention]

[0001]

[Technical Field to which the Invention Pertains] The present invention relates to a substrate processing apparatus that carries out processing that alters the thickness of the film that is formed on the surface of semiconductor substrates used for manufacturing semiconductor apparatuses and glass substrates used for manufacturing liquid crystal panels (hereinafter, referred to generically as "substrate").

[0002]

[Prior Art] Various kinds of processing are applied in order to form patterns, etc., on substrates. Among such kinds of processing, there is a kind of processing whereby the thickness of the film that is formed on the substrate is altered, such as for example etching. However, requests for miniaturization of patterns on substrates have grown in recent years, and it is indispensable to manage the amount of change in film thickness in processing that alters the film thickness in order to form such minute patterns.

[0003] Accordingly, when for example etching is carried out, the apparatus is configured such that the operator measures the thickness of the substrate by a film thickness meter that has been separately installed prior to the input of the substrate into the substrate processing apparatus, and then again conveys the substrate after etching to the film thickness meter and measures the thickness of the substrate once more. Then the operator carries out a process wherein he calculates the amount of etching for the substrate from the difference in film thickness before and after processing, and readjusts the processing conditions in the event that this etching amount is not a suitable value.

[0004]

[Problems that the Invention Attempts to Solve] In the above-described management of the etching amount, that is, the amount of alteration of the film thickness, the need arises

to halt the operation of the substrate processing apparatus since the operator needs to convey the substrate being processed to the film thickness meter that has been separately installed and it is also necessary to input and remove the substrates and dummy substrates that are the object of measurement.

[0005] In addition, examination of the amount of change in the film thickness is performed at a frequency of only about once per day so as to prevent a decline in throughput due to stoppage of operation. Therefore, in the event that abnormalities are found in the examination of the amount of change in film thickness, the need arises to change over time from which substrate the production of defective substrates began, out of the many substrates processed between the previous examination and the current examination.

[0006] Moreover, it is necessary to modify the setting of the conditions of the substrate processing apparatus based on the film thickness and the film quality of the film that is formed on the surface of the substrate in order to maintain suitably the amount of change in the film thickness, but since it is not possible to carry out examination of the amount of change in film thickness frequently owing to the above-described circumstances, restrictions are applied so that the film thickness, etc. of the substrates that are processed between one examination and the following examination must be fixed. As a result, when a substrate with a different film thickness, etc. is erroneously processed, the problem arises that all substrates of that type end up as defective substrates.

[0007] Accordingly, the present invention takes as its purpose the provision of a substrate processing apparatus that can solve various problems like those described above, that is, that can manage suitably the amount of change in the thickness of the film that is formed on the surface of the substrate.

[0008]

[Means for Solving the Problems] The invention in Claim 1 is a substrate processing apparatus that performs the prescribed processing for substrates, and is equipped with (a) a transfer part that has a substrate transfer means that carries out the transfer of the substrate, (b) multiple processing parts that include a film thickness alteration processing part that alters the thickness of the that is formed on the surface of the substrate with a processing liquid, and that are disposed in the area around the above-mentioned transfer part, and (c) a film thickness measurement means that measures the thickness of the film before and after the processing by the above-mentioned film thickness alteration processing parts; and in that the above-mentioned substrate transfer means carries out the transfer of the substrate to each of the above-mentioned multiple processing parts.

[0009] The invention in Claim 2 is the substrate processing apparatus described in Claim 1, wherein the above-mentioned film thickness alteration processing parts carry out etching that alters the thickness of the oxidized film that is formed on the surface of the substrate.

[0010] The invention in Claim 3 is the substrate processing apparatus described in Claim 1 or Claim 2, and is further equipped with a means that calculates the amount of change in the thickness of the substrate before and after the processing by the above-mentioned film thickness alteration processing parts based on the measurement results from the above-mentioned film thickness measurement means.

[0011] The invention in Claim 4 is the substrate processing apparatus described in Claim 3, and is further equipped with a modification means that modifies the processing

conditions of the substrate in the above-mentioned film thickness alteration processing part based on the amount of change in the thickness of the film that is calculated.

[0012] The invention in Claim 5 is the substrate processing apparatus described in Claim 1 to Claim 4, and is further equipped with a checking means that checks the kind of film based on the measurement results for the thickness of the film prior to the processing by the above-mentioned film thickness varying processing parts by the above-mentioned film thickness measurement means.

[0013] The invention in Claim 6 is the substrate processing apparatus described in Claim 5, wherein the processing conditions of the substrate in the above-mentioned film thickness alteration processing parts are modified based on the results of the checking by the above-mentioned checking means.

[0014] The invention in Claim 7 is the substrate processing apparatus described in Claim 1 to Claim 6, wherein the above-mentioned film thickness measurement means are composed as a single film thickness measurement part that is disposed on the above-mentioned transfer part, and measures the thickness of the film both before and after processing by the above-mentioned film thickness alteration processing means.

[0015] The invention in Claim 8 is the substrate processing apparatus described in Claim 1 to Claim 6, and is further equipped with (a) a carry-in part that is disposed in the area around the above-mentioned transfer part, and stores the substrate prior to processing by the above-mentioned film thickness alteration processing part, and (b) and a carry-out part that is disposed in the area around the above-mentioned transfer part, and stores the substrate after processing by the above-mentioned film thickness alteration processing part; and the above-mentioned film thickness measurement means is equipped with (a) a first film thickness measurement part that measures the thickness of the film prior to processing by the above-mentioned film thickness alteration processing means, and (b) a second film thickness measurement part that measures the thickness of the film after processing by the above-mentioned film thickness alteration processing means.

[0016] The invention in Claim 9 is the substrate processing apparatus described in Claim 1 to Claim 8, wherein the above-mentioned film thickness measurement means has (a) a measurement tip for measuring the thickness of the film of the substrate, (b) a position information storage means that stores the position information about where the above-mentioned measurement tip should be positioned relative the substrate during measurement, and (c) and a movement means that moves the above-mentioned measurement tip based on the above-mentioned position information.

[0017] The invention in Claim 10 is the substrate processing apparatus described in Claim 1 to Claim 8, wherein the above-mentioned film thickness measurement means has (a) an area sensor that obtains the image of the prescribed range of the substrate, (b) an area determination means that determines the area to be measured on the substrate from the above-mentioned image, and (c) a film thickness computation means that calculates the thickness of the film in the above-mentioned area to be measured.

[0018]

[Mode of Working of the Invention] <1. Mode of the First Working> Figure 1 is a plan that shows the composition of the substrate processing apparatus 1, which is the mode of the first working of this invention. This substrate processing apparatus 1 carries out sheet-type etching of the film of oxidized film, etc., that is formed beforehand on the surface of

a substrate for the substrate 9 of a semiconductor. Due to this, the film thickness is reduced to a suitable value.

[0019] The substrate processing apparatus 1 has at its center a transfer part 60 that has a transfer robot 61 that transfers the substrate 9, and it has, such that they are connected to the transfer part 60, a carry-in part 10 that stores the substrate 9 prior to etching (unprocessed) that is carried in from outside the apparatus, a carry-out part 20 that stores the substrate 9 after etching (processed) that is carried to the outside the apparatus, an etching part 30 that applies etching to the substrate 9, a washing part 40 that applies washing to the substrate9, and a drying part 50 that applies drying to the substrate 9.

[0020] In the substrate processing apparatus 1, a film thickness measurement part 70 that measures thickness of the film that is formed on the surface of the substrate 9 that is held in place by the transfer robot 61 is further provided in the upper surface of the transfer robot 61.

[0021] Figure 2 is a view showing a frame format of the transfer route of the substrate 9 in this substrate processing apparatus. An explanation is provided below about the composition and the processing operations of this substrate processing apparatus with reference to Figure 2.

[0022] The carrier 91 is transferred from outside the apparatus and can be loaded on the carry-in part 10, and the unprocessed part 9 is carried in to the substrate processing apparatus 1 in a state where a prescribed number of substrates are housed in this carrier 91.

[0023] The substrates 9 that are carried in by the carry-in part 10 are inputted one at a time to the etching part 30 along the transfer route Ca shown in Figure 2 by means of the transfer robot 61 via the transfer part 60. The carrier 91 rises up and down at the carry-in part 10, so that the carry-in part 10 and the transfer robot 61 can carry out the receipt and transfer [of the substrates], and the carrier robot is configured such that a hand that moves horizontally rotates in a horizontal plane on a rotating stand 61a (see Figure 1).

[0024] The substrate 9 inputted into the etching part 30 is provided with the prescribed chemical solution, and etching is applied thereto.

[0025] When the etching is finished, the substrate 9 is removed from the etching part 30 by the transfer robot 61, and inputted to the washing part 40 along the transfer route Cb. Then washing that employs pure water, etc., is applied to the substrate 9.

[0026] The substrates that have undergone washing are removed from the washing part 40 by the transfer robot 61 and inputted to the drying part 50 along the transfer route Cc, and drying is applied to them.

[0027] After that, the substrates are removed from the drying part 50 by the transfer robot 61 and housed in the carry-out part 20 along the transfer route Cd. The carrier 91 rises and falls at the carry-out part 20 as well.

[0028] Owing to the above series of operations, the unprocessed substrate 9 is removed from the carry-in part 10, after which etching, washing and drying are applied and it is returned to the carry-out part 20.

[0029] An explanation was provided above of the composition and processing operations of the substrate processing apparatus 1 for this invention. An explanation is next provided of the composition and operation for the measurement of the thickness of the film (oxidized film, etc.) that has been formed on the surface of the substrate 9 in this substrate processing apparatus.

[0030] Figure 3 is an oblique view that shows the state of a film thickness measurement part 70 that has been installed on the transfer part 60 of the substrate processing apparatus 1. The film thickness measurement part is composed such that the measurement tip 71 and the film thickness meter 72 are connected with an optic fiber, the measurement tip 71 is installed on the transfer part 60 such that it is positioned on the upper surface of the transfer robot 61, and the thickness of the film of the substrate 9 in a state where it is held in place by the transfer robot 61 is measured. In addition, the film thickness meter 72 is disposed in a position that is separated from the measurement tip 71.

[0031] The position where this measurement tip 71 is disposed is the position where it is possible to measure the thickness of the substrate 9 at the shared passage position P of the transfer route Ca where the substrate 9 is removed from the carry-in part 10 by the transfer robot 61 and the transfer route Cb where the substrate 9 from the drying part 50 is housed in the carry-out part by the transfer robot 61 as shown in Figure 2. Therefore, the thickness of the film of the substrate 9 both before and after the etching can be measured in this substrate processing apparatus 1.

[0032] Figure 4 is a block diagram that shows the composition that processes information from the film thickness measurement part 70. As shown in Figure 4, the substrate processing apparatus 1 has an etching amount calculation part 81 that is connected to the film thickness measurement part 70, and a display part 82 that displays the etching amount, which is the amount of change of film thickness and an part for correcting the etching conditions 83 that corrects the etching conditions, which are the processing conditions at the etching part 30, are connected to this etching amount calculation part 81. In addition, this part for correcting the etching conditions 83 is connected to the means for memorizing the etching conditions 33a of the control part 33 that controls the operation of the etching part 30.

[0033] As shown in Figure 4, the measurement tip 71 of the film thickness measurement part 70 has lens part 73, and is connected by an optic fiber 74 to this lens part 73 and the film thickness meter 72. The lens part 73 is opposed to the main surface 9f of the substrate 9 on which the film is formed during measurement, that is, when the substrate 9 is in the already described shared passage position P, and it plays the roles of emitting light for measurement from the optic fiber 74 towards the main surface 9f and returning the reflected light from the main surface 9f to the optic fiber 74. In addition, the lens part 73 is configured such that it can be moved freely in a horizontal direction by a drive mechanism 75. Owing to this, the irradiation of light for measurement and the acquisition of reflected light for whatever part of the main surface 9f is desired are enabled. Moreover, the drive mechanism 75 is separated from the inside of the transfer part 60 by a bellows 76 made of resin.

[0034] The film thickness meter 72 that is connected to the optic fiber 74 supplies light for measurement to the optic fiber 74 and acquires from the optic fiber 74 the reflected light from the main surface 9f, and calculates the thickness of the film on the main surface 9f by analyzing the wavelength of the obtained reflected light.

[0035] As explained above, a film thickness measurement part 70 has been provided on the transfer part 60, and owing to this it becomes possible to measure with a single film thickness measurement part the thickness of the film of the substrate 9 before etching and the thickness of the film of the substrate 9 after etching.

[0036] An explanation is next provided of the measurement operation in the film thickness measurement part 70.
[0037] Figure 5 is a block diagram that shows the composition that controls the operation of the film thickness measurement part 70, and Figure 6 is a flow chart that shows the flow of the operation.
[0038] The drive mechanism 75 is a drive mechanism with two axles that can move the lens part 73 along a horizontal plane that is parallel to the main surface 9f of the substrate 9. Then, this drive mechanism 75 is controlled by the position management part 84.
[0039] The position control part 84 has a part for memorizing the position for film thickness management 84a that memorizes the film thickness position, which is the position in the prescribed region on the substrate 9, and the position control part 84 reads the position information where the lens part 73 should be positioned from the part for memorizing the position for film thickness management 84a (Step S11) at the start of the film thickness measurement operation.
[0040] Figure 7 is a figure that shows the pattern that is formed by the film on the substrate 9. In general, an area called the TEG (test element group) is provided on the substrate 9 as the specific area for managing film thickness, and 92 provides an illustrative example of such an area.
[0041] When the position information is read from the part for memorizing the position for film thickness management 84a, the position control part 84 drives the drive mechanism 75, and the lens part 73 is disposed in a position where it is possible to measure the film thickness of the area 92 on the substrate 9 (step S12). Then, when the lens part 73 is disposed in the prescribed position, the signal indicating that the disposition is concluded is transmitted to the film thickness meter 72, and the film thickness measurement part 70 measures the film thickness of the region 92 (step S13).
[0042] In this manner, it is possible to measure suitably with the drive mechanism 75 and the position control part 84 the film thickness of the specific area of the substrate pattern that is set beforehand for the center, outer periphery, etc., of the substrate 9 based on the film thickness management position that is memorized beforehand in the part for memorizing the position for film thickness management 84a in the case of this substrate processing apparatus 1. Therefore, it is possible to measure directly a prescribed area for different kinds of substrates by modifying this film thickness management position in accordance with the type of substrate 9 to be processed, so efficient and accurate management of the film thickness can be performed. The input of the type of substrate 9 may be an input determined by the operator, and it may be an input from the film type confirmation part 83a shown in Figure 4 (the operation of the latter is described below).
[0043] Figure 8 shows another mode of the film thickness measurement part 70, and shows only the composition that corresponds to Figure 5. The same numbers of the key have been used for those items whose composition is identical to that in Figure 5. In addition, the composition for calculating the etching amount is the same as the composition shown in Figure 4. Figure 9 is a flow chart that shows the flow of the operation of the film thickness measurement part 70 shown in Figure 8.
[0044] Compared to the apparatus shown in Figure 5, the film thickness measurement part 70 shown in Figure 8 differs greatly insofar as the end of the measurement tip serves as the area sensor 73a, and visual signal from the area sensor 73a is sent through the cable 74a to the film thickness meter 72. In addition, the film thickness meter 72 has a

measurement area determination part 72a that analyzes the visual signal and a film thickness calculation part 72b calculates the film thickness based on the visual signal.

[0045] In the measurement by the film thickness measurement part 70 shown in Figure 8, first of all, the position information is read from the part for memorizing the position for film thickness management 84a (step S21), and the position control part 84 controls the drive mechanism 75 and moves the area sensor 73a to a position where it is possible to capture the image of the prescribed area on the substrate 9 (step S22). When the area sensor 73a is disposed on the target position, the position control part 84 sends a signal that the disposition is concluded, and the acquisition of the image by the area sensor 73a is carried out (step S23).

[0046] The region on the substrate 9 captured by the area sensor 73a is not restricted to the region 92 exclusively used for measuring film thickness shown in Figure 7, and it may also be a region where a device structure that actually serves as a product is formed as shown by 93. Here, the image captured by the area sensor 73a is sent to the film thickness meter 72, and the measurement area determination part 72a carries out a pattern analysis of the image and checks whether or not the area sensor 73a is positioned in the prescribed position (step S24).

[0047] If it is determined that the area sensor 73a is not positioned in the prescribed position, the position control part 84 reads the position information of the next candidate from the part for memorizing the position for film thickness management 84a and moves the area sensor 73a to the position of the next candidate (steps S25 and S26). After that, acquisition of the image is carried out again (step S23).

[0048] In the event that it is confirmed that the area sensor 73a is positioned in the prescribed position, the measurement area determination part 72a extracts the specified pattern in the image and determines the area to be measured (steps S25 and S27). Figure 10 shows an example of an image when the area sensor 73a takes a picture of the area 93 shown in Figure 7. The measurement area determination part 72a specifies the area 932 that has a certain extent of size such as the land from the circuit pattern in the image 931 and determines that it is the area to be measured. Then, the film thickness calculation part 72b calculates the thickness of the film that is formed on the substrate from the information like the pixel concentration in the determined area 932 (step S28).

[0049] In this manner, it is possible to specify the area to be measured not only for an area to manage the specific film thickness of the center, outer periphery, etc., of the substrate 9, but also for the structure of an actual device that is formed on the substrate 9, in the case of the film thickness measurement part shown in Figure 8. Owing to this, efficient and accurate film thickness management is realized.

[0050] In the event that the area sensor 73a is utilized, it is not necessary to adjust precisely the relative position relationship of the substrate 9 and the area sensor 73a, so it is possible to measure the film thickness of many kinds of substrate 9 without providing a drive mechanism 75. In this case, movement of the area sensor 73a is not carried out, so higher speed measurement is realized.

[0051] In addition, a wide-range area sensor and a local area sensor, and there is also a method whereby the position where the local area sensor should be positioned is calculated with the wide-range area sensor, after which film thickness measurement is performed with the local area sensor.

[0052] In addition, it may be configured such that a lens part is provided on the measurement tip 71, and an area sensor is provided on the film thickness meter 72 and the lens part and the area sensor are connected with an optic fiber.
[0053] An explanation is next provided of the operation after calculation of the film thickness in the substrate processing apparatus 1 with reference to Figure 4.
[0054] The measurement results, which are the thicknesses of the film after etching that are measured by the film thickness measurement part 70, are inputted to the etching amount calculation part 81. The difference in these film thicknesses is calculated at the etching amount calculation part 81, and the etching amount, which is the amount of change in film thickness before and after etching, is calculated. The calculated etching amount is displayed in the display part 82 so that it is shown to the operator, who is carrying out the operation and management of the substrate processing apparatus 1.
[0055] The etching amount calculated with the etching amount calculation part 81 is sent to the part for correcting the etching conditions 83, and a check is made about whether or not the etching amount is a suitable value. As a result, the operation of the substrate processing apparatus continues as is if the etching amount is suitable, but when it becomes clear that the etching amount is not suitable the part for correcting the etching conditions 83 modifies the etching conditions. Concretely, it modifies the concentration, components and temperature of the chemical fluid and modifies such conditions as the amount of chemical fluid.
[0056] The modified etching conditions are sent to the means for memorizing the etching conditions 33a of the etching part 30 and memorized. Owing to this, the control part 33, which controls the operation of the etching part 30, carries out etching with reference to these modified etching conditions. Concretely, it corrects the concentration, components and temperature of the chemical fluid that is provided on the substrate 9, and the amount of chemical fluid is also corrected.
[0057] An explanation was provided above about the processing operation and the film measurement operation of the substrate processing apparatus 1 for the present invention, but since a film thickness measurement part is provided on the transfer part 60, which is the shared passage position of the substrate 9 before and after processing, in this substrate processing apparatus 1, it is possible to measure the film thickness each time a substrate 9 is removed from the carrier 91 inside the carry-in part 10, and also each time a substrate 9 is housed in the carrier 91 inside the carry-out part 20. As a result, it is possible to check the etching amount every time etching is done, and even when inappropriate etching is detected the substrates for said processing are treated as defects, and there is no large-scale occurrence of defective substrates. That is, it is possible to carry out properly the management of the longevity of the chemical fluid, and at the same it is possible to keep to an absolute minimum the occurrence of defective substrates even if substrates whose film quality differs somewhat are inputted at each loading.
[0058] In addition, since the film thickness measurement in this substrate processing apparatus 1 is performed automatically in the process of the transfer of the substrate 9, the trouble and waste of time involved in stopping the substrate processing apparatus and the operator's carrying the substrate to the film thickness meter as has been the case to date no longer arise. As a result, it is possible to provide for improvement of throughput.
[0059] Moreover, since it is possible in the case of this substrate processing apparatus 1 to measure the thickness of the film before and after the etching by means of one film

thickness processing part 70, it is naturally possible to aim a reduction of the cost of the apparatus compared to a case where two film thickness measurement parts are provided.

[0060] An explanation is next provide of another illustrative embodiment of this substrate processing apparatus 1.

[0061] As shown in Figure 4, in the above-described operation for checking the etching amount, the film thickness measurement results from the film thickness measurement part 70 are inputted to the etching amount calculation part 81, but as shown by the broken line arrow the following operation is possible by inputting this to the film type confirmation part 83a inside the part for correcting the etching conditions 83.

[0062] First of all, the question of whether or not the film thickness and the film quality of the substrate to be processed and the processing state of the etching part 30 are suited to one another is calculated beforehand by the film type confirmation part 83a based on the thickness of the film of the substrate 9 before processing that is measured by the film thickness measurement part 70. Due to this, it is possible to prevent unsuitable etching before it occurs, and to prevent the occurrence of defective substrates.

[0063] Next, a determination is made about whether the film thickness, film quality, etc., and the processing conditions are suited to one another based on the results of the checking of the thickness, etc., of the film of the substrate 9 prior to processing, and if it is determined to be a film type that is suitable for other prescribed processing conditions the part for correcting the etching conditions 83 modifies the processing conditions of the etching part 30 to something suitable. Due to this, it is possible to automatically apply processing that is suitable for various kinds of film thickness and film quality.

[0064] For example, when a substrate processing apparatus 1 that can cope with the processing of substrates 9 with two kinds of film thickness is carrying out continuous processing of one kind of these substrates 9, even if the other kind of substrate is erroneously mixed in, the film type confirmation part 83a determines based on the film thickness measurement results from the film thickness measurement part 70 that the latter is not a substrate 9 that should be processed under the current processing conditions. Moreover, when it can be confirmed from the film thickness measurement results that it is the other kind of substrate 9, the part for correcting the etching conditions 83 modifies the contents of the means for memorizing the etching conditions 33a, and processing of the other kind of substrate 9 is continued.

[0065] In this manner, it is not only possible for this substrate processing apparatus 1 to check the etching amount every time that substrates 9 are processed, but also possible for it to suitably handle automatically etching for substrates with various kinds of film quality.

[0066] <2. Mode of the Second Working> Figure 11 is a plan that shows the composition of a substrate processing apparatus 1a that is the second mode of working for this invention. The substrate processing apparatus 1a is an apparatus that applies sheet-type etching to substrates on which a film has been formed beforehand on the surface.

[0067] Other than the fact that this substrate processing apparatus 1a has two film thickness measurement parts, it is identical to the substrate processing apparatus 1 for the mode of the first working in terms of the composition of the apparatus and the processing operations. Therefore, the transfer route of the substrate 9 is identical to the transfer route shown in Figure 2. In addition, Figure 11 uses the same numbers and letters of the key for elements whose composition is identical to that in Figure 11.

[0068] In order to measure the thickness of the film of the substrate 9, the substrate processing apparatus 1a has two film thickness measurement parts that are identical to the one in the mode of the first working as the first film thickness measurement part 70a and the second film thickness measurement part 70b. In addition, the first film thickness measurement part 70a is provided on the transfer path 11 of the carry-in part 10, and the second film thickness measurement part 70b is provided on the transfer path 21 of the carry-out part 20.

[0069] Therefore, the first film thickness measurement part 70a can measure the thickness of the film of the unprocessed substrate 9 on the transfer path Ca shown in Figure 2, and the second film thickness measurement part 70b can measure the thickness of the film of the processed substrate 9 on the transfer path Cd. To phrase it differently, the first film thickness measurement part 70a carries out measurements for the unprocessed substrate 9 that it is positioned at the stage immediately after it is removed from the carry-in part 10, and the second film thickness measurement part 70b carries out measurements for the processed substrate 9 that it is positioned at the stage immediately before it is housed in the carry-out part 20.

[0070] Figure 12 is a block diagram that shows a machine for processing the measurement results from the first film thickness measurement part 70a and the second film thickness measurement part 70b. The specifics of processing are identical with the mode of the first working other than the fact that two film thickness measurement parts are present. That is, the etching amount is calculated by the etching amount calculation part 81 from the difference of the film thickness before and after processing, and in the event that this etching amount is not suitable the part for correcting the etching conditions 83 corrects the processing conditions. Then, the corrected etching conditions are memorized in the means for memorizing the etching conditions 33a in the control part 33 of the etching part 33. As a result, the concentration, components, temperature, amount, etc., of the chemical fluid that is provided to the substrate 9 by the etching part 30 are adjusted and processing that is appropriate for the substrate 9 to be processed next is applied.

[0071] In addition, as shown by the broken line arrow in Figure 12, the film type confirmation part 83a confirms beforehand the processing conditions based on the film thickness measurement results from the first film thickness measurement part 70a, and the fact that the part for correcting the etching conditions 83 can modify the processing conditions is the same as the mode of the first working.

[0072] As shown above, in the case of this substrate processing apparatus 1a a first film thickness processing part 70a and a second film thickness processing part 70b have been disposed so that it is possible to measure the thickness of the film of the substrate 9 that is located in positions that correspond to the stage before and the stage after the etching part 30, so it is possible to confirm the etching amount each time that a substrate 9 is processed, and even if improper etching is carried out it is possible to discover this quickly. Then, in the event that improper etching due to the action of the part for correcting the etching conditions is discovered, correction of the processing conditions is rapidly done automatically.

[0073] In addition, since these film thickness measurement parts have been disposed on the transfer route, there is no decline in the throughput owing to film thickness measurement.

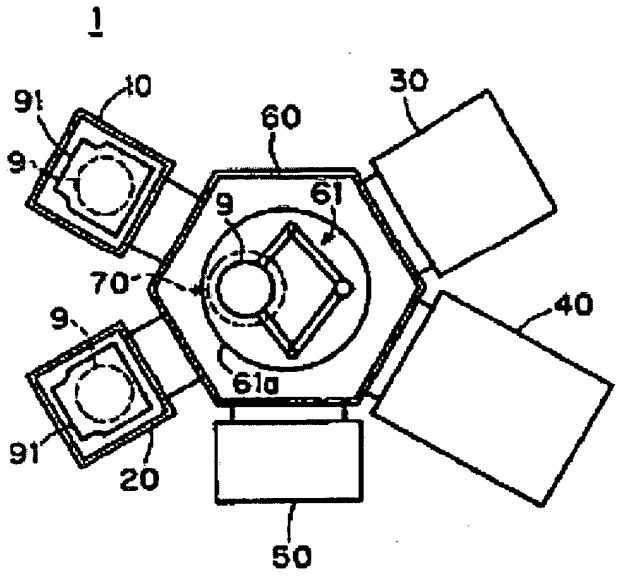
[0074] Moreover, by checking the thickness of the unprocessed substrates from the first film thickness confirmation part 70a, improper etching is prevented before it occurs, and automatic modification of the processing conditions is realized.
[0075] <3. Modified Examples> An explanation was provided above about a substrate processing apparatus for this invention, but this invention is not limited to the mode of the above-mentioned workings and can be modified in various ways.
[0076] For example, an explanation was provided of a substrate processing apparatus that carries out etching in the mode of the above-mentioned workings, but the present invention can also be used provided it is an apparatus wherein the film has been formed beforehand on the substrate and it carries out processing that alters the thickness of the film with a processing fluid.
[0077] In addition, in the mode of the first working the film thickness measurement part is posed in the shared passage position P near the entrance/exit of the carry-in part 10 and carry-out part 20, but it may be provided anywhere assuming that it is a shared passage position before and after etching. For example, it may be provided on the upper center of the transfer part 60, or it may be provided in the vicinity of the entrance/exit of the etching part 30.
[0078] In addition, two separate and independent film thickness measure parts have been provided in the mode of the second working, but there is no need for these to be completely independent. For example, two measurement tips have been provided, but it can be configured such that a film thickness meter is used in common.
[0079] Moreover, the first film thickness measurement part 70a can be disposed anywhere provided that it can measure the thickness of the film of the unprocessed substrate 9, that is, provided that it can make measurements for the substrate that is located in a position corresponding to before the processing that alters the film thickness, and the first film thickness measurement part 70b can be disposed anywhere provided that it can measure the thickness of the film of the processed substrate 9, that is, provided that it can make measurements for the substrate that is located in a position corresponding to later than the processing that alters the film thickness.
[0080]
[Effects of the Invention] In the invention described in Claim 1 to Claim 10, it is possible to measure the thickness of the film that has been formed on the surface of a substrate before and after processing by the film thickness alteration part in the substrate processing apparatus, whereby multiple processing parts that include a film thickness alteration part have been disposed in the area around the transfer part. Owing to this, it is possible to measure the thickness of the film before and after processing with causing any decline in throughput.
[0081] In addition, since in the case of the invention described in Claim 3 it is possible to calculate the amount of change in the thickness of the film each time that processing is carried out, it is possible to confirm quickly whether or not suitable processing has been carried out. Owing to this it is possible to hold to an absolute minimum the occurrence of defective substrates, without unsuitable processing conditions being left as is.
[0082] In addition, since in the case of the invention described in Claim 4 it is possible to modify the processing conditions of the substrate based on the amount of change of the thickness of the film, it is possible to correct quickly improper processing conditions.

[0083] In addition, since in the case of the invention described in Claim 5 it is possible to confirm the type of film before processing, it is possible to prevent unsuitable processing before it occurs, and it is possible to prevent the occurrence of defective substrates.
[0084] In addition, since in the case of the invention described in Claim 6 it is possible to modify the processing conditions of the substrate based on the confirmation results, it is possible to carry out processing suitably for substrates with various kinds of film thickness, etc.
[0085] In addition, since in the case of the invention described in Claim 7 it is possible to measure the thickness of the film that is formed on the surface of a substrate before and after processing with a single film thickness measurement part, so it is possible to aim at a reduction of the price of the substrate processing apparatus.
[0086] In addition, in the case of the invention described in Claim 9 it is possible to measure the thickness of the film at a suitable position on the substrate based on the position information.
[0087] In addition, since in the case of the invention described in Claim 10 it is possible to determine the area to be measured on the substrate from the image, it is possible to carry out accurate film thickness measurement.
[Brief Description of the Figures]
[Figure 1] This is a plan that shows the substrate processing apparatus that is the mode of the first working.
[Figure 2] This is a figure that shows the transfer route of the substrate in the substrate processing apparatus shown in Figure 1.
[Figure 3] This is an oblique view that shows the state of the place where the film thickness measurement part is installed.
[Figure 4] This is a block diagram that shows the composition that processes the film thickness measurement results.
[Figure 5] This is a block diagram that shows the composition that controls the operation of the film thickness measurement part.
[Figure 6] This is a flow chart that shows the flow of the operation during film thickness measurement.
[Figure 7] This is a figure that shows the measurement area on the substrate.
[Figure 8] This is a block diagram that shows another example of the composition that controls the action of the film thickness measurement part.
[Figure 9] This is a flow chart that shows another example of the flow of the operation during film thickness measurement.
[Figure 10] This is a figure that shows an example of the device structure.
[Figure 11] This is a plan that shows the substrate processing apparatus that is the mode of the second working.
[Figure 12] This is a lock diagram that shows the composition that processes the film thickness measurement results.

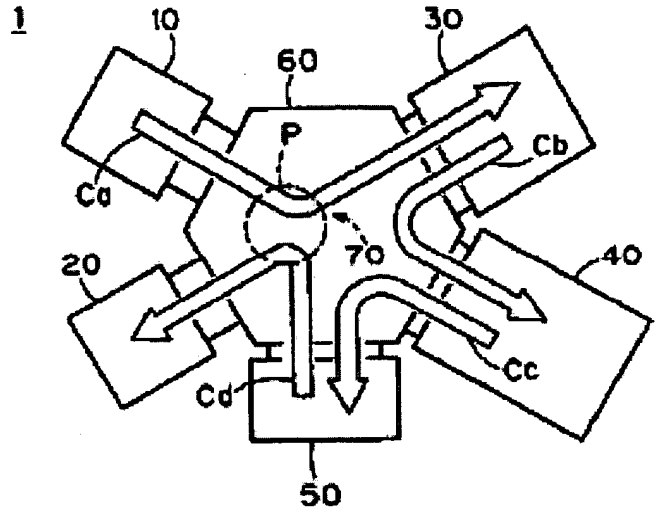
[Key]
1, 1a... Substrate processing apparatus
9... Substrate
10... Carry-in part
20... Carry-out part

30... Etching part
40... Washing part
50... Drying part
60... Transfer part
61... Transfer robot
70... Film thickness measurement part
70a... First film thickness measurement part
70b... Second film thickness measurement part
72a... Measurement area determination part
72b... Film thickness calculation part
73... Lens part
73a... Area sensor
75... Drive mechanism
81... Etching amount calculation
83... Part for correcting the etching conditions
83a... Film type confirmation part
84... Position control part
84a... Part for memorizing the position for film thickness management

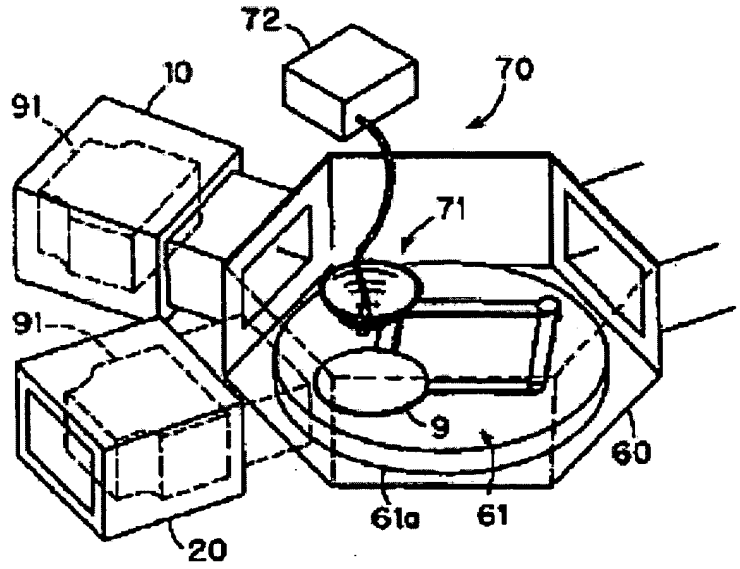
[Figure 1]



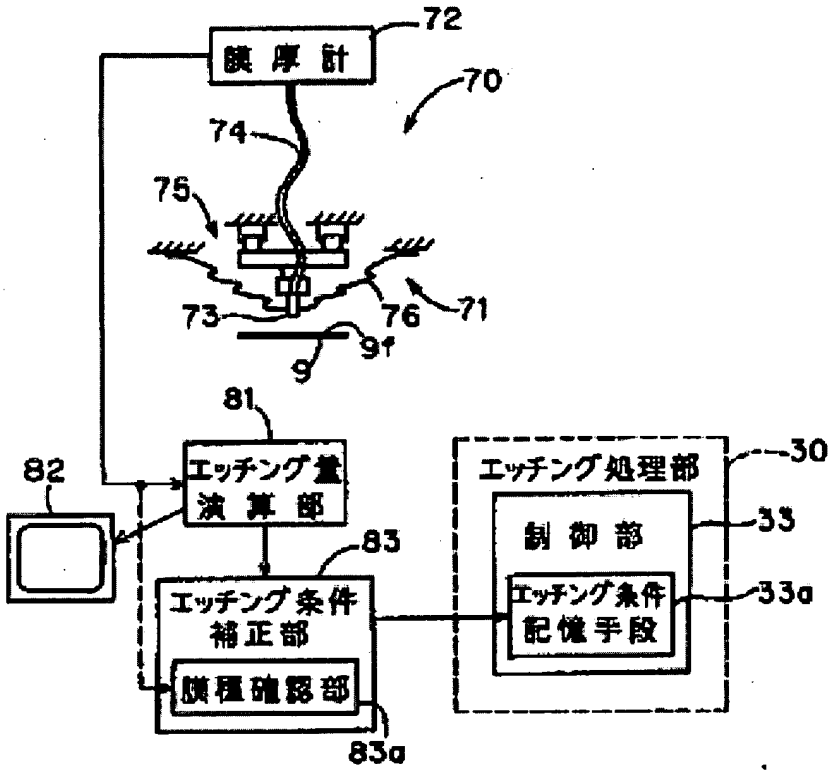
[Figure 2]



[Figure 3]

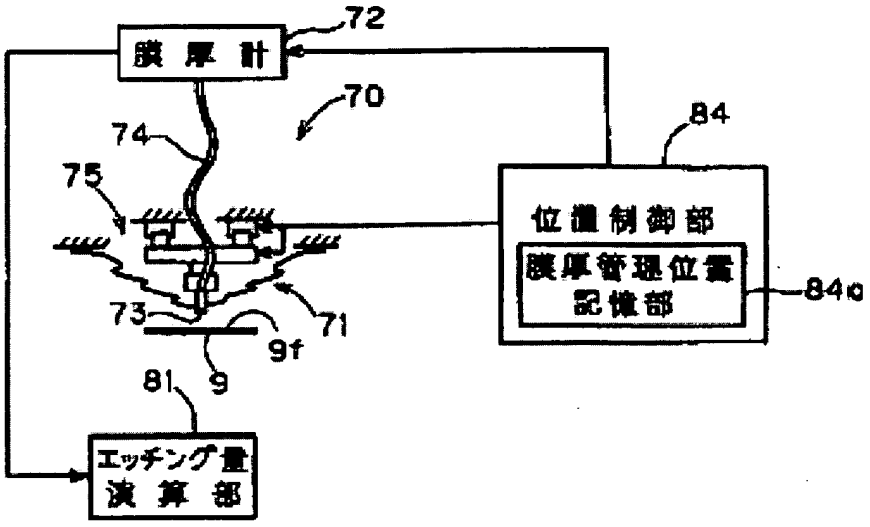


[Figure 4]



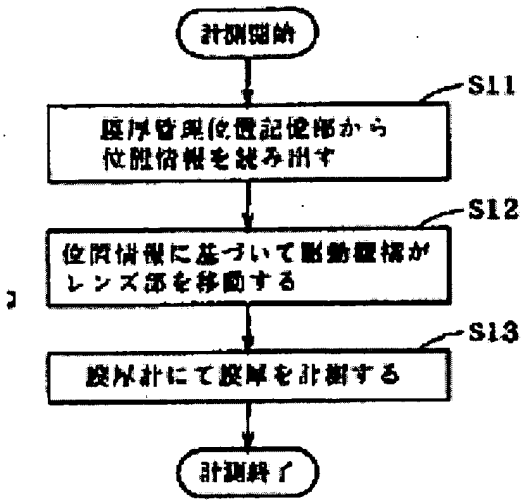
30... Etching part
33... Control part
33a... Means for memorizing the etching conditions
72... Film thickness meter
81... Etching amount calculation part
83... Part for correcting the etching conditions
83a... Film thickness confirmation part

[Figure 5]



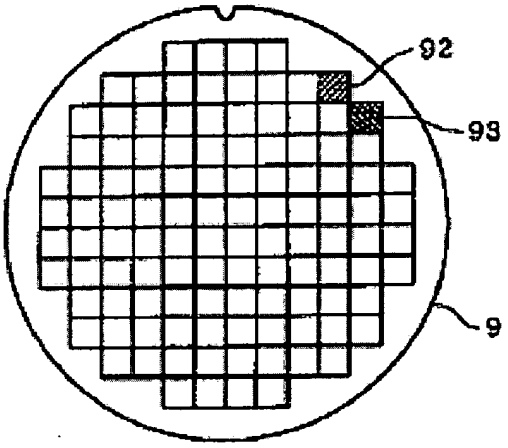
72... Film thickness meter
81... Etching amount calculation part
84... Position control part
84c... Part for memorizing the position for film thickness management

[Figure 6]

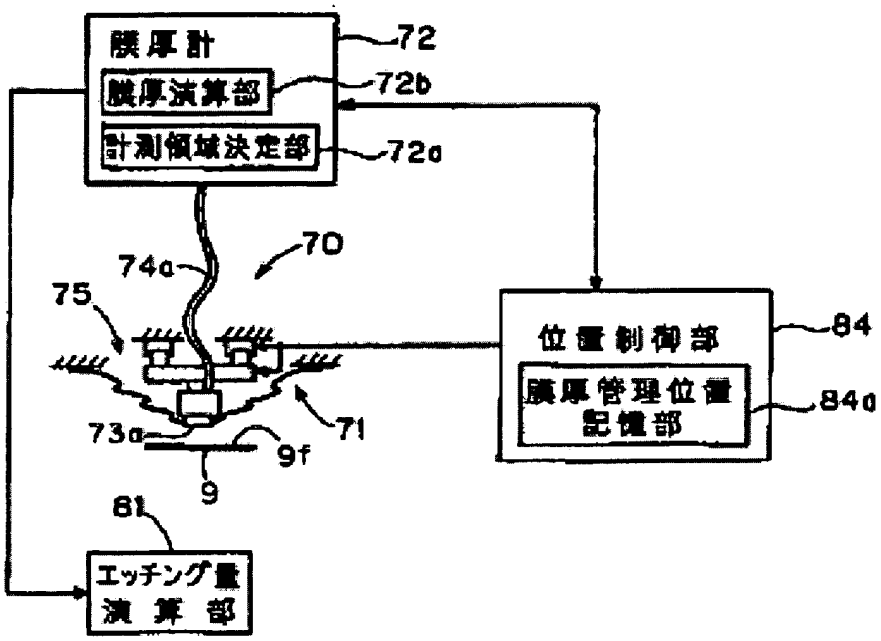


[top oval] Start of measurement
S11... The position information is read from the part for memorizing the position for film thickness management
S12... The drive mechanism moves the lens part based on the position information
S13... The film thickness is calculated by the film thickness meter
[top oval] End of measurement

[Figure 7]

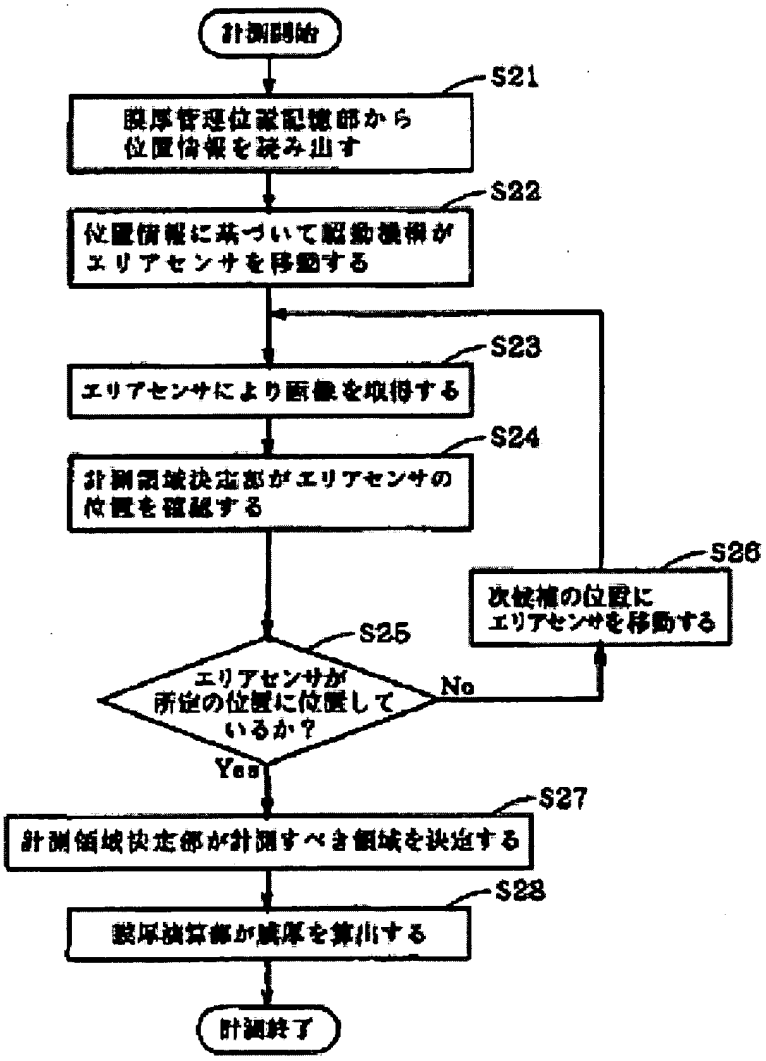


[Figure 8]



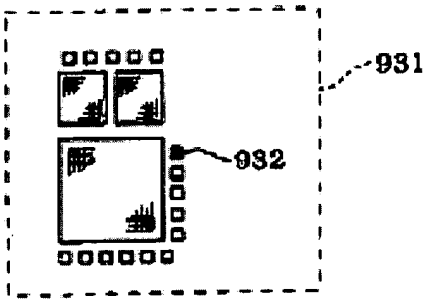
72... Film thickness meter
72a... Measurement area determination part
72b... Film thickness calculation part
81... Etching amount calculation
84... Position control part
84a... Part for memorizing the position for film thickness management

[Figure 9]

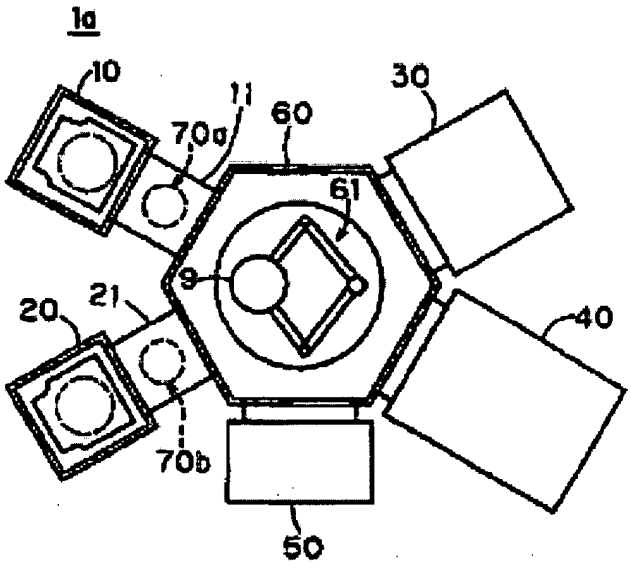


[top oval] Start of measurement
S21... The position information is read from the part for memorizing the position for film thickness management
S22... The drive mechanism moves the area sensor based on the position information
S23... An image is acquired by the area sensor
S24... The measurement area determination part confirms the position of the area sensor
S25... Is the area sensor positioned in the prescribed position?
S26... The area sensor is moved to the position of the next candidate
S27... The measurement area determination part determines the area to be measured
S28... The film thickness calculation part calculates the film thickness
[bottom oval] Start of measurement

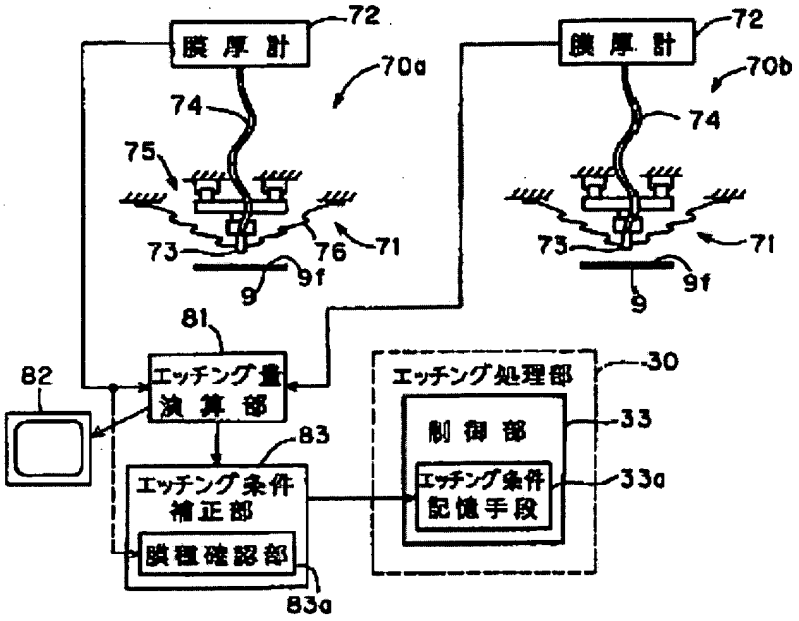
[Figure 10]



[Figure 11]



[Figure 12]



30... Etching part
33... Control part
33a... Means for memorizing the etching conditions
72... Film thickness meter
81... Etching amount calculation
83... Part for correcting the etching conditions
83a... Film type confirmation part